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Microbiology and antimicrobial resistance in pediatric acute rhinosinusitis with acute otitis media

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Abstract

Aim: This study aimed to describe organisms cultured from pediatric acute rhinosinusitis (ARS) with otitis media (OM), as well as current resistance patterns of pathogens.

Material and Methods: The study was conducted from February to October 2022. Children with acute rhinosinusitis and acute otitis media underwent endoscopic-guided cultures at National Otorhinolaryngology Hospital of Vietnam to obtain pathogens and for analysis of antibiotic resistance.

Results: The total of 72 cultures were obtained from 72 children with acute rhinosinusitis and otitis media under the age of 6 years. Gram-negative bacteria were isolated in 48.6% and Gram-positive bacteria in 37.5% of patients. Susceptibility rates of H. influenzae were 100.0% to meropenem and piperacillin/ tazobactam; 55.6% to amoxicillin/ clavulanic acid. Resistance rates of H. influenzae were 100.0% to both cefuroxime and co-trimoxazole. Susceptibility rates of S. pneumoniae were 100.0% to levofloxacin, moxifloxacin, vancomycin, tigecycline, rifampicin and linezolid. Resistance rates of S. pneumoniae were 100.0% to erythromycin, 93.3% to tetracycline and 86.7 to clindamycin. Susceptibility rates of M. catarrhalis were 100.0% to meropenem, ceftazidime, ciprofloxacin, levofloxacin, gentamycin and doxycycline. Resistance rates of M. catarrhalis were 100.0% to co-trimoxazole, 87.5% to azithromycin.

Discussion: This study highlights that H influenzae, S. pneumoniae, M. catarrhalis, and S. aureus are the major bacteria found in pediatric acute rhinosinusitis with acute otitis media. Because of different patterns of antibiotic resistance, a targeted antibiotic treatment according to culture sensitivity studies is needed for more effective therapy.

Keywords

Microbiology, Antimicrobial Resistance, Rhinosinusitis, Otitis Media

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Introduction

Rhinosinusitis is defined by the inflammation of the nasal cavity mucosa and sinuses mucosa, which may or may not include bone lesions [1]. It is commonly infective in origin and usually results from simple viral rhinosinusitis (the common cold) [2]. This primary infection has the effects of reducing ciliary function, causing edema of the nasal mucosa and sinus ostia, and increasing nasal secretions. These stagnant secretions within the sinuses may become secondarily infected with bacteria, commonly Streptococcus or Haemophilus. Certain conditions may predispose to sinusitis. These include any condition that blocks the ostia of the sinuses, such as nasal polyps, or conditions that interfere with airflow through the nose, for example, a deviated septum. The roots of the upper teeth often project into the maxillary sinus, and thus dental infections can also lead to sinusitis [2-4].

Otitis media (OM) is the most common diagnosis for medical visits in preschool-age children and the most frequent indication for outpatient antibiotic use in the USA and the world, with estimated annual public health costs totaling US$ 2.8 billion annually [5-7]. OM is characterized by signs and symptoms of middle-ear effusion (MEE), defined as fluid collection in the middle ear. It may also include otorrhea (drainage of fluid from the middle ear), which occurs after perforation of the tympanic membrane or through ventilation tubes placed previously. OM can be classified as acute otitis media (AOM), otitis media with effusion (OME), recurrent AOM, and chronic suppurative OM (CSOM). Each has a separate basis in its best course of treatment. AOM is defined by the presence of middle-ear inflammation and fluid of sudden onset and often presents with constitutional symptoms consistent with infection, such as fever and pain [8]

Although the bacteriology of pediatric chronic rhinosinusitis appears to be well established, research on current bacterial resistance patterns is limited. Numerous studies have been conducted to characterize antibiotic resistance in rhinosinusitis recently, either via endoscopic middle meatus sampling or intraoperative biopsy. The subjects of these studies, however, are mainly adults, and pediatric patients are seldom included. Furthermore, large-scale surveillance examining antimicrobial susceptibility of upper respiratory pathogens reveals an ongoing evolution and geographic variation in bacterial resistance, which highlights the need for updated data on antimicrobial susceptibility in different regions and countries [9].

Material and Methods

A prospective study was conducted from February to October 2022 at the National Otorhinolaryngology Hospital in Hanoi, Vietnam. This study was approved by the Ethics Committee of the hospital (IRB number 021022/NOH). Consent was obtained from all participants in this study.

Patients were included if they were under 6 years of age and presented with typical symptoms of acute rhinosinusitis (purulent nasal drainage/postnasal discharge and nasal congestion) and acute otitis media lasting less than 12 weeks. Ear, nose, and throat examination was carefully conducted, and purulent discharge was collected via the endoscopic middle meatus for bacterial cultivation.

Samples from the sinus were sent to the microbiologic laboratory within 1 hour. In the microbiology laboratory, aerobic specimens were plated on blood agar plate and chocolate agar, and cultured for 24 hours at 35°C. Potentially pathogenic organisms that grew on culture were identified and reported semi-quantitatively using standard techniques. Analysis of the patterns of antimicrobial resistance was conducted for specific antibiotics according to different aerobic bacteria.

Ethical Approval

Ethics Committee approval for the study was obtained.

Results

The study included 72 patients (48 males, 24 females) diagnosed with acute rhinosinusitis and acute otitis media. The study group consisted of patients of both sexes with ages ranging from 0 to 5 years. This group of patients was divided into two groups according to the age criterion: from 0 to 2 years old (42 patients, 58.3%); from 3 to 5 years old (30 patients, 41.7%).

Culture results showed that 13.9% (10 cultures) of aspirates yielded normal upper airway flora or no growth at all. Gram-negative bacteria were isolated in 48.6% (35/72) and Gram-positive bacteria in 37.5% (27/72) of patients. Polymicrobial growth (more than one isolate per culture) was noted in 0% of the cultures. The analysis of culture results is shown in Table 1. This study analyzed the resistance of Haemophilus influenza, Streptococcus pneumonia, and Moraxella catarrhalis to major antibiotics (Table 2). The resistance rate of S. pneumoniae isolates and the resistance rate of M. catarrhalis isolates are shown in Table 3.

Susceptibility rates of M. catarrhalis were 100.0% (8/8) to meropenem, ceftazidime, ciprofloxacin, levofloxacin, gentamycin and doxycycline. Resistance rates of M. catarrhalis were 100.0% (8/8) for co-trimoxazole, 87.5% (7/8) for azithromycin.

Table 1. Analysis of culture results

Bacterial species	n	%
Staphylococcus aureus	7	9.7
Staphylococcus epidermidis	3	4.2
Kocuria rosea	1	1.4
Haemophilus influenzae	27	37.5
Moraxella catarrhalis	8	11.1
Streptococcus mitis	1	1.4
Streptococcus pneumoniae	15	20.8
Total	62	86.1

Table 2. Resistance rate of H. influenzae isolates (N=27).

Antibiotic	S	I	R
Cefuroxime			27
Ceftriaxone	17	9	1
Cefotaxime	17	9	1
Amoxicillin/clavulanic acid	15	11	1
Ciprofloxacin	25		2
Levofloxacin	25		2
Clarithromycin	8	4	15
Azithromycin	13	1	13
Co-trimoxazole			27

Table 3. Resistance rate of S. pneumoniae isolates and M. catarrhalis isolates.

Antibiotic	S	I	R
S. pneumoniae isolates (N=15)			
Benzylpenicillin	12	3	
Ceftriaxone	13	2	
Cefotaxime	9	6	
Vancomycin	15	7	
Chloramphenicol	14	1	
Erythromycin			15
Azithromycin			1
Clindamycin		2	13
Tetracycline		1	14
Trimethoprim/Sulfamethoxazole	3	1	11
M. catarrhalis isolates (N=8)			
Cefuroxime	1	4	3
Ceftriaxone	3	3	2
Cefotaxime	3	3	2
Amo + A.Clavulanic	7	1	
Azithromycin	1		7
Co-trimoxazole			8

Discussion

The higher rate of positive bacterial cultures can be explained by the fact that in this study, the cases were mainly located in the provinces and rural areas, where the use of older generation antibiotics was not effective in killing bacteria. Some negative culture results may be due to the fact that patients have been using strong and prolonged antibiotics prior to admission to central hospitals. Other possible causes of negative cultures are the role of anaerobic bacteria.

Overall, the most common bacteria isolated were Heamophilus influenzae (37.5%) followed by Streptococcus pneumoniae (20.8%), Moraxella catarrhalis (11.1%), Staphylococcus aureus (9.7%). Less common bacteria were Streptococcus mitis and Kocuria rosea (1.4%). Subgroup analysis revealed that 69.4% of bacterial isolates were pathogens commonly implicated in acute bacterial rhinosinusitis (Haemophilus influenza, Streptococcus pneumonia, and Moraxella catarrhalis). Several recent studies by other authors have also shown similar results that Haemophilus influenza, Streptococcus pneumonia, and Moraxella catarrhalis are still the three most common bateria in acute rhinosinusitis [10-14].

Susceptibility rates of H. influenzae were 100.0% (27/27) to meropenem and piperacillin/tazobactam; 92.6% (25/27) to ciprofloxacin and levofloxacin; 55.6% (15/27) to amoxicillin/clavulanic acid. Resistance rates of H. influenzae were 100.0% (27/27) to both cefuroxime and co-trimoxazole. C.-H. Hsin et al showed that the susceptibility rates of H. influenzae were 100.0% to ciprofloxacin and cefuroxime. This means that in Vietnam, the resistance rates of H. influenzae to cefuroxime is almost very high compared to other countries [9].

Susceptibility rates of S. pneumoniae were 100.0% (15/15) to levofloxacin, moxifloxacin, vancomycin, tigecycline, rifampicin and linezolid. Resistance rates of S. pneumoniae were 100.0% (15/15) to erythromycin, 93.3% (14/15) to tetracycline and 86.7 (13/15) to clindamycin.

Susceptibility rates of M. catarrhalis were 100.0% (8/8) to meropenem, ceftazidime, ciprofloxacin, levofloxacin, gentamycin and doxycycline. Resistance rates of M. catarrhalis were 100.0% (8/8) to co-trimoxazole, 87.5% (7/8) for azithromycin.

Conclusion

This study shows that H influenzae, S. pneumoniae, M. catarrhalis, and S. aureus are the major bacteria found in pediatric acute rhinosinusitis with acute otitis media. The study also revealed a different pattern of antibiotic resistance compared with previous studies performed in children. When prescribing antimicrobial therapy for children with acute rhinosinusitis, current patterns of antibiotic resistance should be considered, which may vary according to different geographic areas. For rhinosinusitis recalcitrant to empirical antibiotics, targeted antibiotic treatment according to culture sensitivity studies is needed for more effective therapy.

Scientific Responsibility Statement

The authors declare that they are responsible for the article's scientific content including study design, data collection, analysis and interpretation, writing, some of the main line, or all of the preparation and scientific review of the contents and approval of the final version of the article.

Animal and human rights statement

All procedures performed in this study were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. No animal or human studies were carried out by the authors for this article.

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Conflict of interest

None of the authors received any type of financial support that could be considered potential conflict of interest regarding the manuscript or its submission.

References

1. Jaszkul KM, Grzybowski M, Phillips T. Otolaryngology-Head and Neck Surgery clinical electives in undergraduate medicine: a cross-sectional observational study. J Otolaryngol Head Neck Surg. 2022; 51(1): 42.

2. Kardos P, Malek FA. Common Cold - an Umbrella Term for Acute Infections of Nose, Throat, Larynx and Bronchi. Pneumologie. 2017; 71(4): 221-6.

3. Fokkens WJ, Lund VJ, Hopkins C, Hellings PW, Kern R, Reitsma S, et al. European Position Paper on Rhinosinusitis and Nasal Polyps 2020. Rhinology. 2020; 58(Suppl. 29): S1-464.

4. Qadri H, Andrabi DZ, Nemade SV, Shinde KJ, Naik C, Yeolekar A, et al. Medical Graduate's Basic Knowledge and Clinical Skills Assessment in Otorhinolaryngology Post Internship. Indian J Otolaryngol Head Neck Surg. 2019; 71(Suppl. 1): S162-6.

5. Lewis AT, Backous D, Choi BY, Jaramillo R, Kong K, Lenarz T, et al. Healthcare consumption among subjects with otitis media undergoing middle ear surgery-analysis of cost drivers. Eur Arch Otorhinolaryngol. 2023; 280(1): 175-81.

6. Noorbakhsh KA, Liu H, Kurs-Lasky M, Smith KJ, Hoberman A, Shaikh N. Cost-effectiveness of management strategies in recurrent acute otitis media. J Pediatr. 2023; 256:11-17.e2.

7. van Uum RT, Venekamp RP, Pasmans CTB, de Wit GA, Sjoukes A, van der Pol AC, et al. Cost of childhood acute otitis media in primary care in the Netherlands: economic analysis alongside a cluster randomised controlled trial. BMC Health Serv Res. 2021; 21(1): 193.

8. Danishyar A, Ashurst JV, Acute Otitis Media. Treasure Island (FL): StatPearls; 2022.

9. Hsin CH, Su MC, Tsao CH, Chuang CY, Liu CM. Bacteriology and antimicrobial susceptibility of pediatric chronic rhinosinusitis: a 6-year result of maxillary sinus punctures. Am J Otolaryngol. 2010; 31(3): 145-9.

10. Brook I. Acute sinusitis in children. Pediatr Clin North Am. 2013; 60(2): 409-24.

11. DeMuri G , Wald ER. Acute bacterial sinusitis in children. Pediatr Rev. 2013; 34(10): 429-37; quiz 437.

12. Marom T, Alvarez-Fernandez PE, Jennings K, Patel JA, McCormick DP, Chonmaitree T. Acute bacterial sinusitis complicating viral upper respiratory tract infection in young children. Pediatr Infect Dis J. 2014; 33(8): 803-8.

13. Leung AKC, Wong AHC. Acute Otitis Media in Children. Recent Pat Inflamm Allergy Drug Discov. 2017; 11(1): 32-40.

14. Sawada S, Matsubara S. Microbiology of Acute Maxillary Sinusitis in Children. Laryngoscope. 2021; 131(10): E2705-11.

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